

# Modern Concepts of Cardiovascular Disease

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## THE ELECTROCARDIOGRAPHIC DIAGNOSIS OF CARDIAC INFARCTION

### PART I

In the study of patients suspected of cardiac infarction the electrocardiogram should be considered in conjunction with the clinical findings. Either alone may be inadequate. Together, they supplement each other, and enable one to diagnose correctly the great majority of cases. The evaluation of tracings should not be delegated to a technician. It should be done by a physician who knows electrocardiography and coronary artery disease and who is cognizant of the patient's clinical findings.

The electrocardiographic signs of recent cardiac infarction may be enumerated as follows: (1) RS-T interval deviations; (2) certain characteristic changes in the QRS complex; (3) the so-called "cove plane" or "coronary" T wave; (4) huge T waves; and (5) changes occurring in the ventricular complex from day to day.

The time relations between the acute infarction and the appearance of the various electrocardiographic phenomena are important. (1) RS-T interval deviations appear in the experimental animal within two minutes after a large coronary artery has been obstructed. In man, however, it is well known that the typical electrocardiographic signs may not be seen in a tracing taken shortly after the attack but may appear later. We interpret this sequence of events as being due to a small original infarction which subsequently enlarges, or to a slow development of complete occlusion. Our experience has led us to believe that a large infarct will give electrocardiographic evidence of its presence as soon after the onset as it is possible to take a tracing. The RS-T interval deviations may disappear within a few days after the attack, or may persist for a week or ten days. Sometimes they come and go over a long period. Their disappearance probably antedates the complete healing of the lesion by several weeks at least. (2) Certain sig-

nificant QRS complex changes may appear promptly but tend to lag behind the RS-T interval deviations. They often persist for months—sometimes for years. (3) The coronary T wave may appear early and persist for months. After the passage of time it usually loses its distinctive features and looks like any other inverted T wave. Eventually it may give way to a normal upright T wave. (4) Huge T waves are apt to appear a few days after the attack. They may persist for weeks. Associated findings appear to indicate that they denote an active process. (5) Changes which occur from day to day in the tracing likewise signify, if other causes are ruled out, that the lesion has not yet healed.

Until about four years ago, patients with cardiac infarction were studied electrocardiographically with Einthoven's three conventional limb leads only. Although many infarcts were diagnosed by this technique, there were some proven cases in which the electrocardiogram failed to yield evidence of the lesion. In 1931 it was found by animal experimentation, and later by clinical observation, that certain leads from the chest wall supplement the findings in limb leads and markedly increase the efficiency of the electrocardiographic method for the diagnosis of cardiac infarction.

Since that time many different chest leads have been used and many more probably will be advocated. However, for practical purposes we find that in the great majority of cases only one chest lead is necessary. For this lead one electrode is applied to the front of the chest over the apex impulse of the heart and connected to the right arm lead wire. The other electrode is placed on the back of the left chest directly opposite the anterior electrode and connected to the left arm or left leg lead wire. This lead has been called lead IV. In some cases additional information may be obtained by moving the anterior electrode to other points on the precor-

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dium. However, in the average case this is not necessary.\* The normal lead IV shows an insignificant, usually diphasic P wave. The QRS complex consists of a prominent initial downward deflection, always exceeding 2 mm., followed by an upward deflection. The T wave is directed downward in all normal adults, but may be iso-electric or upward in children with no signs of heart disease. (Unpublished observations of Dr. Joseph Edeiken.)

The signs which will appear in the electrocardiogram in a case of cardiac infarction depend upon the location of the lesion. There are two common types, the anterior and the posterior, each with its own distinctive electrocardiographic pattern.

(A) Anterior Infarction: Obstruction of the left anterior descending coronary artery or of one of its branches is usually found in cases with this lesion. The infarct is located in the anterior wall of the left ventricle. It frequently involves the apex and the anterior half of the interventricular septum. The electrocardiographic signs which it produces may vary a little depending upon the size and exact location of the lesion. The typical case shows the following characteristics:

During the acute stage the RS-T interval deviations are upward in lead I, downward in lead III and downward in lead IV. The QRS complex usually shows no initial downward deflection in lead IV. In lead I, approximately 50% of cases at some time during the acute stage show a Q wave. To be significant this Q wave must conform to certain specifications: it must be at least 1 mm. deep and 20% of the size of the largest R wave in any limb lead. R-I must be 5 mm. or less in height. In this anterior type of lesion, RS-T interval deviations may not appear in limb leads, but they almost always occur in lead IV. Sometimes this lead shows the characteristic signs when the limb leads are entirely normal. Lead IV is more useful in studying cases of anterior infarction than in any other type.

During healing the RS-T interval deviations tend to disappear and T waves appear which are opposite in direction to the previous RS-T interval deviations. T-1 is inverted, T-3 and T-4 become upright. The QRS complex changes mentioned above tend to persist. The electrocardiogram of a typical case during the healed stage is almost as characteristic as the tracing taken during the acute stage. The findings in lead IV have a high degree of diagnostic reliability. When this lead shows no initial downward deflection of QRS and an upright T wave, there is little doubt that the patient has had an infarct in the anterior surface of the left ventricle. The presence in lead I of both a significant Q wave and an inverted T wave is of almost equal diagnostic value, but is less frequent. These signs of healed infarction may persist for years. However, they may disappear entirely sooner or

later. Consequently their absence does not rule out a scar in the anterior wall of the left ventricle.

Certain anterior infarcts seem incapable of producing the complete typical picture described above, probably because of their small size. In some of these cases during the process of healing, lead IV shows huge upright T waves 13 mm. or more in height. These large upright waves have not as yet been seen in any other condition. Consequently they constitute a valuable diagnostic sign.

(B) Posterior Infarction: Occlusion of the right coronary artery or of one of its major branches usually is found in cases with this lesion. The infarct is located in the posterior wall of the left ventricle, adjacent to the interventricular septum, and usually involves the posterior part of the septum. The lesion occasionally extends across to involve a small part of the right ventricular wall. The typical case shows the following electrocardiographic characteristics:

During the acute stage the RS-T interval deviations are downward in lead I, slightly upward in lead II, definitely upward in lead III and upward in lead IV. There is a deep Q wave in lead III; lead II may show a small Q wave; the initial downward deflection of QRS in lead IV is preserved. In this type of lesion the RS-T interval in lead IV may be normal when lead III shows a definite deviation. Lead IV is apt to give less information in the study of posterior infarction than in the study of anterior lesions. However, in the few cases of this type in which RS-T interval deviations are absent from limb leads, they are apt to appear in chest leads.

During healing the RS-T interval deviations tend to disappear and T waves appear which are opposite in direction to the previous RS-T interval deviations. T-3 and often T-2 are inverted. T-4 is usually inverted (normal). The deep Q wave in lead III and sometimes that in lead II tend to persist. The electrocardiogram during the healed stage in the typical posterior lesion with a deep Q III, small Q II and inversion of T-2 and T-3 is often helpful in diagnosing the presence of the posterior wall scar. However, some cases lack the signs in lead II showing only a Q wave and inverted T wave in lead III. These signs in lead III are seen without cardiac infarction in some patients with transversely placed hearts, and occasionally in other conditions. They are not entirely reliable for diagnosing the presence of a scar in the myocardium, especially in patients with high diaphragms.

It is probable that certain small posterior infarcts produce huge inverted T waves in lead IV during the acute and subacute stage without giving the complete typical picture described above. Since a few normals have T waves in lead IV, 14 mm. deep, a wave to be considered significant should be larger than this.

*(To be continued)*

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\* Placing the second electrode on the left leg, instead of on the back of the chest, gives an electrocardiogram which is in many cases similar to that of lead IV and probably equally useful in the diagnosis of coronary occlusion. Sometimes tracings taken with these two leads differ greatly from one another. Nevertheless, the statements which will be made regarding lead IV are in general applicable to both.

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